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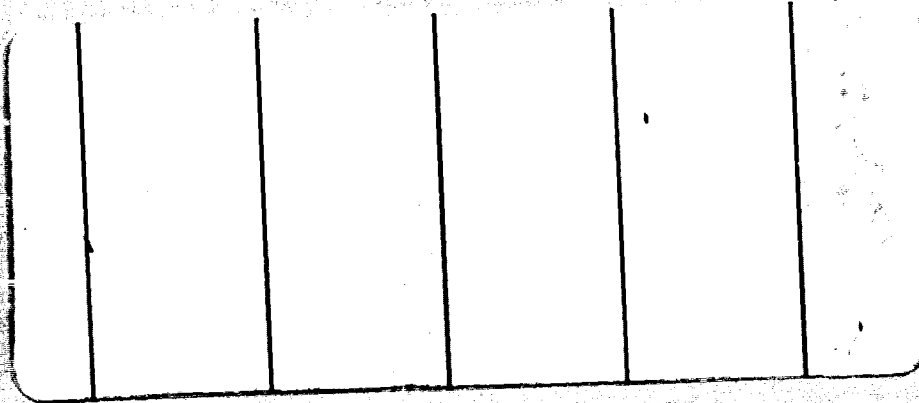
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THE AEROSPACE CORPORATION

STS ANCILLARY EQUIPMENT STUDY
FINAL REPORT

Prepared by
Advanced Mission Analysis Directorate
Advanced Orbital Systems Division

May 1977


Systems Engineering Operations
The Aerospace Corporation
El Segundo, California

Prepared for
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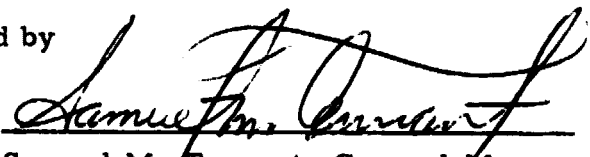
STS ANCILLARY EQUIPMENT STUDY
FINAL REPORT

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ABBREVIATIONS

DSP	Defense Support Program
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EVA	Extravehicular Activity
IECM	Induced Environment Contamination Monitor
IPS	Instrument Pointing System
IUS	Interim Upper Stage
MDAC	McDonnell Douglas Astronautics Company
MMC	Martin Marietta Corporation
MMSE	Multi-Use Mission Support Equipment
OFT	Orbital Flight Test
RI	Rockwell International
RMS	Remote Manipulator System
S/L	Spacelab
SSPD	Summarized NASA Payload Descriptions
SSUS	Solid Spinning Upper Stage
STS	Space Transportation System
TBD	To Be Determined

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1. INTRODUCTION

The initial plan for this year's Ancillary Equipment Study was to expand and update the results of last year's study (see Reference 1). Further definition and justification of ancillary equipment common to NASA and DoD users were to be developed. The study was to utilize the results of the NASA in-house Multi-Use Mission Support Equipment (MMSE) studies (References 2, 3, and 4); the NASA-sponsored Martin Marietta MMSE studies for FY 1976 (References 5, 6, 7, and 8); the NASA-sponsored Rockwell International ancillary equipment studies (References 9 and 10); the 1976 SAMSO-sponsored McDonnell Douglas DoD STS Payload Interface Support Study (References 11, 12, and 13); and the 1976 SAMSO-sponsored Rockwell International DoD Shuttle Integration Support Study (References 14, 15, 16, 17, and 18).

The multi-use mission support equipment (MMSE) study objectives were to provide detailed requirements, design definitions, and acquisition plans for spaceborne MMSE. The revised MMSE (launch site) catalog provided ground equipment planning information. The study was to build upon MMSE definitions developed during the previous year's work. The objective of the Aerospace study was to describe the potential for NASA/DoD common usage of ancillary equipment.

As a result of changes in the MMSE program at NASA, the Aerospace study was redirected. NASA's original intention was to provide MMSE for STS users. This approach is generally being followed for ground support equipment by KSC. However, the approach for spaceborne equipment changed. Some of the spaceborne equipment is being provided by the Shuttle program or the Spacelab program. The remainder

will be provided by the payloads. If general-purpose equipment is justified, the first NASA payload program to develop the equipment will be funded to develop the equipment for general application.

The revised objective of this study was to provide a record of what is known about STS ancillary equipment and its current status. No new data were to be generated in the redirected Aerospace study. The output of the study is a User Reference Book for Ancillary Equipment. The User Reference Book includes formatted data and information for both spaceborne and ground ancillary equipment. The basic ground rule for the study was to assemble and record the current information on ancillary equipment including the information from the latest NASA and DoD studies referenced above.

2. STUDY OBJECTIVE

The objective of this study was to assemble, record, and publish what is currently known about STS ancillary equipment and to publish a User Reference Book for NASA's use. The data in this document should be user-oriented and designed to eventually contain sufficient information so that a potential user would be able to evaluate whether he could use the described ancillary equipment or if he would need to design and fabricate a payload-unique item. The document will also provide references that the user could use to obtain additional details and requirements to aid in his evaluation and decision.

3. APPROACH

The approach taken in this study (see Figure 3-1) to accomplish the study objective (see Section 2) involved the following tasks.

1. Establish a Set of References

A set of references containing information on potential ancillary equipment was established. These reference documents describe the results of various studies performed for NASA and DoD, as well as in-house NASA studies. The references include reports, briefings, catalogs, and lists of ancillary equipment items. Some examples of these references are last year's Aerospace Corporation report (Reference 1), Martin Marietta Corporation's MMSE work over a two-year period, DoD STS Payload Interface Studies accomplished by McDonnell Douglas, and Rockwell International's DoD Shuttle Integration Studies.

2. Review of Reference Documents

The reference documents were reviewed to extract candidates for ancillary equipment. These candidates were then categorized and organized into a master ancillary equipment list. In addition to the candidate name, data about the item were noted for future use. Data in the reference documents included equipment descriptions, intended application (to Spacelab payloads and/or automated spacecraft), potential users, first user and year of first use, and cost estimates. The equipment lists, one for ground equipment and one for spaceborne equipment, were extensive. As recent studies were completed, additional items were identified and added.

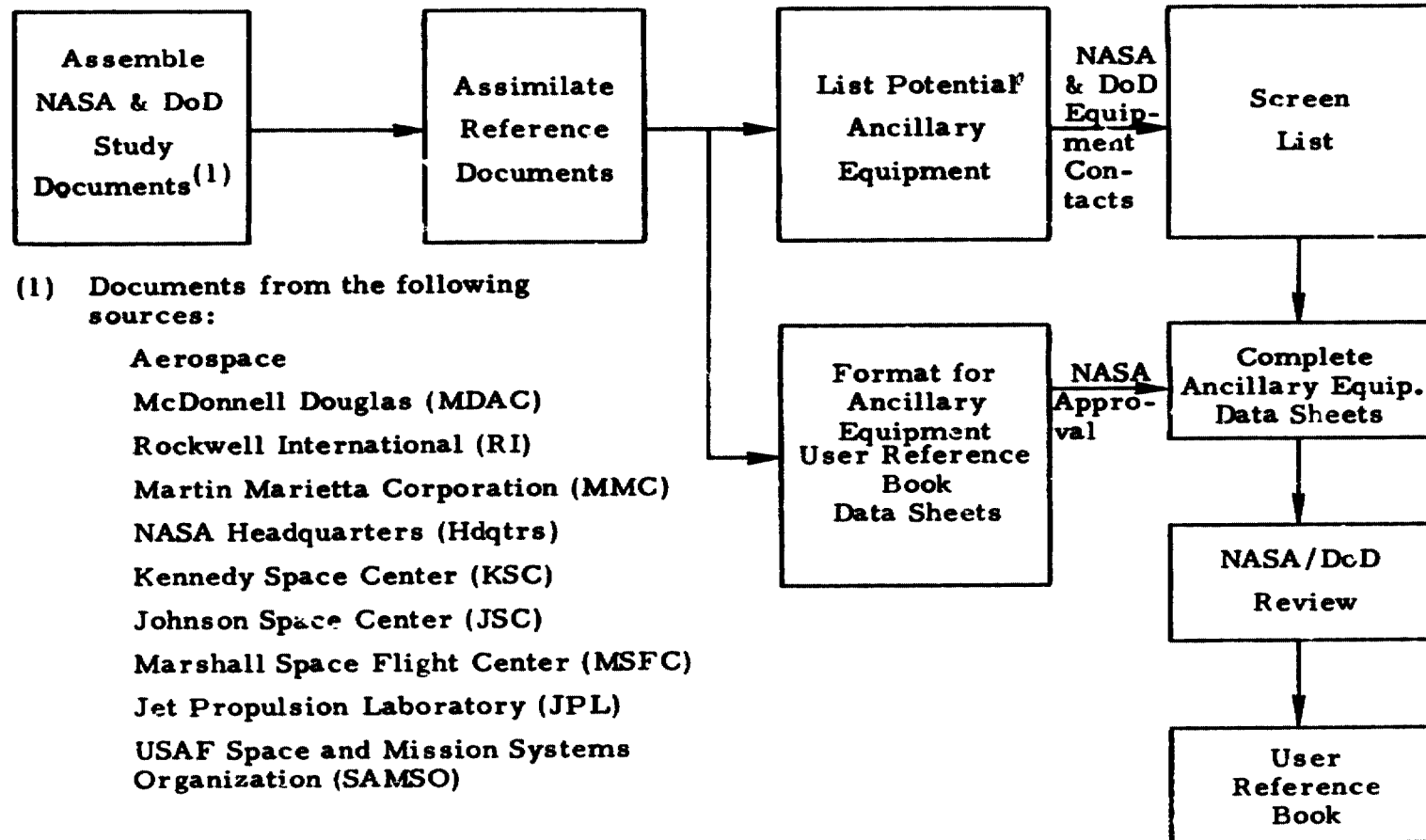


Figure 3-1. Study Flow

3. Screen List of Candidates

The next task was to screen the ancillary equipment list for items of interest to NASA and/or DoD to determine those that had a reasonable potential of becoming candidates for ancillary equipment. To accomplish this, contacts were made by telephone with various NASA Headquarters and Center personnel. The initial contacts were provided by the NASA Study Director.

4. Establish Format for User Reference Book

The format for the user reference book data was then prepared. This form is user-oriented and contains data describing the equipment, stating its capability and function, application to types of payloads, potential users, estimated cost, alternative to using this standard equipment, status, and references for additional data. The form was reviewed by the NASA Study Director and approved.

5. Select Data from Reference Documentation

Having screened the list of candidates for ancillary equipment and established the format for the User Reference Book, the next task was to find and select data from the reference documentation and complete the data form for each of the equipments selected.

4. REFERENCE DOCUMENTATION

Over the past several years, studies which consider Space Transportation System (STS) ancillary equipment have been performed by various contractors for NASA and DoD. A number of NASA in-house studies have also been made. These studies covered a variety of general areas including transportation, payload integration, payload interfaces, multi-use mission support equipment (MMSE), kits for the Shuttle system, and specific studies of equipment (such as power supplies, pointing devices, contamination monitors, and manned maneuvering units). These studies resulted in the initiation of the development of some equipments. Study documents in the form of interim and final reports, progress briefings, and equipment catalogs were the reference sources used in this study. Discussions with NASA and DoD contacts resulted in additional reference documentation. In all, more than 50 references form the data bank used in this study. These references are listed in Section 8.

5. ANCILLARY EQUIPMENT LISTS

The ancillary equipment obtained from the documentation review were divided into two major categories: (1) spaceborne equipment, and (2) ground equipment. Within these categories the individual equipment items are listed into subcategories like those shown in Tables 5-1 and 5-2. These tables contain, in addition to the equipment category name, some data of general interest. Reference documents where each ancillary equipment item is discussed are identified by number (see Section 8). In column 3 of the tables, those category items which are sponsored by NASA's Office of Space Flight are indicated by a "yes." "Open" or "no action" indicates that the decision has not been made yet as to whether to support the item or not. The applicability of the equipment to automated payloads or Spacelab payloads (or both) is designated by an "A" or "S," respectively. The number of payload programs which could use the equipment and the potential number of Shuttle flights on which the equipment could be used are noted, when estimates are available. The first potential user and the year of first use are listed. Equipment cost estimates, broken down into non-recurring and recurring costs, are provided in some of the reference documents and included on the list. Very low cost items were screened from the list when cost and operating advantages for standardization would be small.

Discussions with NASA and DoD contacts were held for the purpose of determining which of the many potential ancillary equipment items were of further interest to NASA and/or DoD (i.e., funded and in development, planned for future funding, or planned for additional study). The list of categories and equipment items within a category were considerably reduced from that originally proposed and are presented in Tables 5-1 and 5-2. In the ground equipment area, all five categories

Table 5-1. Ancillary Equipment List - Ground Equipment

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
1. Launch Site Transportation System	2, 8	Yes	A S	All	OFT #3	1979	
2. Launch Site Service Charts	2, 8	Open	A S	TBD	TBD	1979	
3. Multipurpose Work Stands Access Platforms, Slings	2, 8	Yes	A S	All	OFT #3	1979	
4. Cargo Integration Test Equipment (CITE)	2, 4, 11	Yes	A S	All	OFT #3	1979	
5. Outsized Payload Transportation System	5, 6	Yes	A S	TBD	TBD	TBD	

- (1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.
- (2) First user nomenclature is from 1975 SSPD.
- (3) Upper number is the non-recurring cost; lower number is the recurring cost.

Table 5-2. Ancillary Equipment List - Spaceborne Equipment

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
1. Pointing and Stabilization Systems	5, 6, 50, 55, 56	No	S	108	SL #2		
2. Electrical Cabling	1, 5, 6, 10, 23	Yes	A	(20-49)	HE-24-A AS-02-A	1979	71.0 659.6
3. Contamination Monitoring	5, 6, 27, 52	Yes	A S	1st Six + As Req'd	OFT #1	1979	
4. Manned Maneuvering Unit	53	Yes	A S	All Free Flyers	TBD	TBD	TBD
5. Auxiliary Payload Power System	5, 6, 10, 40, 43	Open	A S	8 + (80+)	Space Process	1981	
6. Payload Specialist Station	5, 6, 25	Yes	A S	All (307)	OFT #1	1979	TBD
7. RTG Cooling	5, 6, 41	No	A	At Least 9 P/L	TBD	1983	1,600.0 1,000.0/ Unit

(1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.

(2) First user nomenclature is from 1975 SSPD.

(3) Upper number is the non-recurring cost; lower number is the recurring cost.

Table 5-2. Ancillary Equipment List - Spaceborne Equipment (Cont'd)

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
8. Second Ku-Band Antenna	5, 6, 21, 44, 45, 47	Yes	A S	Potent. All	OFT #1	1979	None 3,700.0
9. Orbiter-to-Payload Structure	5, 6, 14, 15, 18	No	A	All Non-IUS (100)	TBD	TBD	
10. Fluid Systems	5, 6, 10	Open	A S	50% Auto 35% S/L	TBD	TBD	
11. Umbilical Connector	14, 15	No	A		TBD	TBD	113.5 75.5/unit
12. Avionics Equipment	5, 6, 17	STS	A S	See Item	See Item	See Item	See Item
13. Attitude Reference Sensors	5, 6	No Action	S	66% S/L Users	TBD	1979	
14. IPS Environmental Canisters	5, 6	No	S	11 (23)	AS-41-S AS-42-S	1980	446.2 444.6

(1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.

(2) First user nomenclature is from 1975 SSPD.

(3) Upper number is the non-recurring cost; lower number is the recurring cost.

Table 5-2. Ancillary Equipment List - Spaceborne Equipment (Cont'd)

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
15. Orbiter Bay Environmental Measurements (OBEM)	5, 6	No	A S	1st Six + As Req'd	OFT #1	1979	
16. Payload Shrouds	5, 6, 11, 29	No	A	39 (54)	AS-02-A	1981	2,224.5 1,632.9
17. IUS-To-Payload Structure	5, 6	No	A	See Item	See Item	1980	
18. Spacelab-to-Payload Structure	5, 6	No	S	6 (20)	See Item	1980	
19. On-Orbit Servicing Equipment	5, 6, 51	No	A	TBD	MMS	TBD	
20. Electrical Power Equip.	5, 6, 17	No	A S	See Item	See Item	See Item	
21. Purge Systems	5, 6, 23	Open	S	21 (109)	HE-11-S	1980	2,223.3 1,620.9

- (1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.
- (2) First user nomenclature is from 1975 SSPD.
- (3) Upper number is the non-recurring cost; lower number is the recurring cost.

Table 5-2. Ancillary Equipment List - Spaceborne Equipment (Cont'd)

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
22. Multi-Discipline Small Equipment Facility	5, 6, 23	No	S	As Req'd	As Req'd	As Req'd	350.0 360.0
23. EMC/EMI Equipment	5, 6	No	S	TBD	TBD	TBD	200.0
24. Booms/Deployment Mechanisms	5, 6	No	S A	See Item	See Item	See Item	
25. Film Storage Vault	5, 6	No Spacelab	S	As Req'd		1980	
26. Experiment Support Conister	5, 6, 23	No	S	11 (54)	HE-11-S SO-17-S	1980	120.0 190.6
27. Payload Related Software		No	A S				
28. EVA Workstation	54	Yes	A S	As Req'd	As Req'd	As Req'd	

- (1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.
- (2) First user nomenclature is from 1975 SSPD.
- (3) Upper number is the non-recurring cost; lower number is the recurring cost.

Table 5-2. Ancillary Equipment List - Spaceborne Equipment (Cont'd)

Category Name	Reference Number	OSF Sponsor	Auto (A) Sp. Lab (S)	No ⁽¹⁾ Users	First ⁽²⁾ User	First Year	Cost ⁽³⁾
29. Crew Related Cameras	54	Open	A S	As Req'd	As Req'd	As Req'd	

(1) Number not in parentheses is the number of potential program users; number in parentheses is the number of potential flights.

(2) First user nomenclature is from 1975 SSPD.

(3) Upper number is the non-recurring cost; lower number is the recurring cost.

are included, however, some of the equipment items within a category have been deleted. On the spaceborne side, several categories have been deleted or postponed and are not included in this study. These deleted categories or items are listed below with a brief explanation.

- Attitude Reference Sensors - Deleted, sensors will be included in the pointing system.
- IPS Environmental Canister - No interest.
- Orbiter Bay Environmental Measurements - Already planned for incorporation in early flights as basic instrumentation.
- Payload Shrouds - Only the DSP sensor requires a contamination shroud, specific protection is planned in other cases.
- IUS-to-Payload Structure - No interest at NASA in multiple user equipment. This is currently a payload-peculiar item.
- Spacelab-to-Payload Structure - No requirements have been specified yet.
- On-Orbit Servicing Equipment - The only requirement to date is for the flight support system for the GSFC Multimission Modular Spacecraft.
- Purge Systems - DSP will use a carry-on system, no other specified requirements.
- Multi-Discipline Small Equipment Facility - Payloads will probably provide these items.
- EMC/EMI - Awaiting better definition of experiment requirements.
- Booms/Deployment Mechanisms - None specified, use RMS.
- Film Storage Vault - Spacelab provided.

- **Experiment Support Canister - Spacelab igloo provided by Spacelab program**
- **Payload Related Software - None identified**
- **EVA Workstation - In Shuttle budget**
- **Crew Related Cameras - No payload requirements specified**
- **Electrical Power Equipment - Items other than battery included in avionics**

6. FORMAT FOR ANCILLARY EQUIPMENT USER REFERENCE BOOK

The data form shown in Table 6-1 was derived with the potential user of ancillary equipment in mind. The data are intended for those potential users attempting to evaluate the equipment for use on his program rather than to build payload-unique equipment. A description of the information under each of the data headings is presented below.

1. Name of Item and Identifying Number

The name of the particular piece of ancillary equipment and an identifying number is presented. The identifying number may be an MMSE number (see References 6 and 8) or a drawing or part number (see item 11 below).

2. Equipment Description

This is a brief description of the item including its intended use and a sketch, outline drawing, or block diagram. This is presented to the user even if the item is conceptual and not hardware. A list of components is also helpful and included when the information is available. This description was obtained from one or more of the references in item 11 below.

3. Physical Characteristics

The size (dimensions or volume) and weight of the item are given. These characteristics were obtained from the references in item 11 below.

Table 6-1. User Reference Book Data Form

- 1. Name of Item and Identifying Number**
- 2. Equipment Description**
- 3. Physical Characteristics**
- 4. Purpose and Intended Application**
 - a. Capability and Function**
 - b. What Types of Payloads**
 - c. What STS Elements are Involved**
 - d. Describe Interface Requirements**
- 5. Identification of First Potential User and Year of First Use**
- 6. Identify All Potential Users**
- 7. Estimate Flight Rate or Number Required**
- 8. Equipment Cost Estimate**
- Development Schedule**
- 9. Potential Value of Equipment**
- 10. Status**
- 11. Reference(s) for Additional Data**
- 12. Contact**

4. Purpose and Intended Application

a. Capability and Function

The actual or proposed capability and function (what can it do -- what are its limitations) are described. Included are specifications, schematics, block diagrams, etc. These data were obtained from the reference material listed in item 11.

b. What Types of Payloads

The types of payloads that could use this item are listed. The types of payloads are: automated, automated with IUS (interim upper stage), automated with SSUS (solid spinning upper stage), and Spacelab payloads. In some cases the payload types were stated in the reference material (item 11), in others judgment was used to identify the type(s).

c. What STS Elements are Involved

This item identifies where in the STS the equipment is used (orbiter, IUS, Spacelab). The STS elements were selected from the description and application of the equipment item.

d. Describe Interface Requirements

Required services such as power and/or cooling from the orbiter, cabling, adaptors, etc. are identified. This material was identified from references listed in item 11 when available.

5. Identification of First Potential User and Year of First Use

The first potential user and the year in which the multiple mission equipment is expected to be used for the first time are both extracted from the reports referenced in the Ancillary Equipment User Reference Book (see item 11), or from discussions with NASA and DoD contacts.

6. Identify All Potential Users

Potential users are designated by nomenclature used in the NASA MSFC 1975 Space Shuttle Payload Description (References 19 and 20). Sometimes only classes of payloads such as Spacelab or automated payloads can be established as users of the equipment. The potential users designated are taken from the 1973 NASA Mission Model by Martin Marietta (see Reference 6) and the list of DoD payloads studied by McDonnell Douglas (see References 11, 12, and 13) and by Rockwell International (see References 14 through 18).

7. Estimate Flight Rate or Number Required

The estimated number of uses is based on a modified NASA/MSFC 572-STS flight traffic model (see Reference 7). The number of multimission equipment units required is based on a study of payload requirements from the traffic model (Reference 7), modified as a result of discussions with study contacts.

8. Equipment Cost Estimate

An estimate of equipment cost is given when the data are available. The cost estimates assumed that new ancillary equipment will be developed and purchased. Cost estimates were provided in the reference material (see item 11). No cost estimates were available for ground equipment.

An estimated development schedule is also included. Development schedule estimates were obtained from one of the references in item 11.

9. Potential Value of Equipment

Savings of this multi-use equipment over payload-unique designs are included here when available. In other cases the alternative to this multi-use equipment is identified.

10. Status

Some of the questions answered in this item are: (1) has this equipment been funded, (2) is it planned for development, and (3) has it just been studied and proposed. The status of the ground equipment was obtained from Reference 2 and discussions with Charles Hart (NASA/KSC). The status of spaceborne equipment was obtained from Reference 9 and discussions with Jack Heberlig (NASA/JSC) and other contacts.

11. Reference(s) for Additional Data

The data provided in this form are necessarily brief. These references are provided for an interested potential user to obtain more details and requirements regarding a specific piece of equipment.

12. Contact

This is the name of the person to contact for information regarding the item of ancillary equipment.

Data were not available for all items in each ancillary equipment description. In these cases the lack of data is shown by "TBD," symbolizing that the information is to be determined.

An example of a completed form taken from the User Reference Book is presented in Table 6-2. This example is for an "Induced Environment Contamination Monitor."

A complete list of ancillary equipment data forms which are in the User Reference Book is shown in Table 6-3. Both ground equipment and spaceborne equipment are listed by equipment categories, as well as listing individual items of ancillary equipment.

Table 6-2. Example of Completed Form From User Reference Book

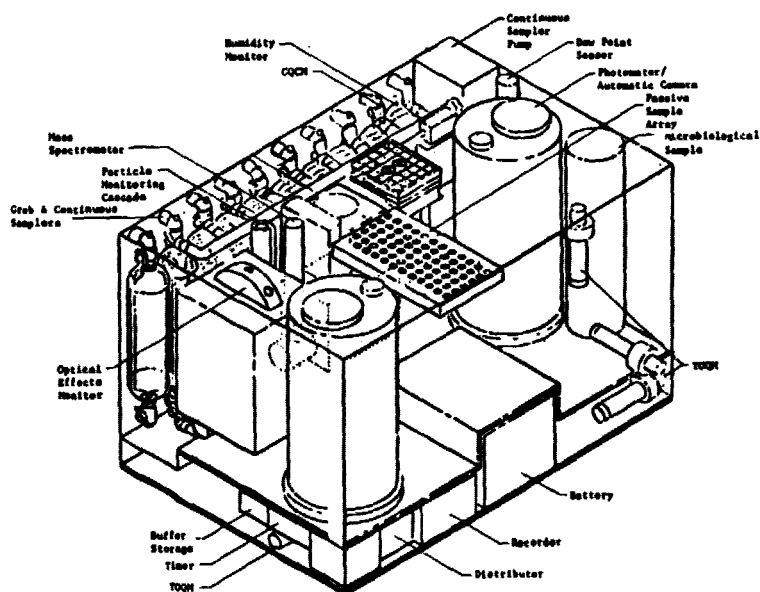
1. NAME OF ITEM AND IDENTIFYING NUMBER:

Induced Environment Contamination Monitor (IECM) - No. TBD

2. EQUIPMENT DESCRIPTION: (See Figure 1)

Includes:

- Mass Spectrometer
- Optical Effects Monitor
- Grab and Continuous Samplers
- Particle Monitoring Cascade
- Humidity Monitor
- Photometer/Camera
- Passive Sample Array
- Microbiological Sampler



**Table 6-2. Example of Completed Form From
User Reference Book (Cont'd)**

3. PHYSICAL CHARACTERISTICS:

- (a) Size: 49.0 x 33.25 x 30 in.
- (b) Weight: 750 lb

4. PURPOSE AND INTENDED APPLICATION:

(a) Function and Capability:

Will conduct an in-depth survey of the potential contamination of experiments and other payloads from the induced environment in and around the STS during launch, deployment, retrieval, and landing. This package will be used for the following:

- (1) Verify the contamination requirements specified in paragraphs 3.6.12.4.1 through 3.6.12.4.6, Vol. X, JSC 07700.
- (2) Provide diagnostic data to identify any sources that contribute to out-of-specification conditions so that corrective action can be taken.
- (3) Measure the contamination effects from delivery, deployment, retrieval, and landing a free-flying payload.
- (4) Perform routine monitoring to detect any anomalous operating conditions such as leaks in the hydraulic, coolant, or fuel system; sloughing off particulates from TPS, insulation, or experiments; outgassing from new components or various experiments.

The specific measurements to be made in the payload bay during times when there is a sensible atmosphere in the payload bay including ascent and descent are:

- (1) Measure aerosol count and size distribution for particles 0.3 micron and larger at concentration levels corresponding to Class 100.
- (2) Measure deposition of non-volatile residue with a detection threshold of 0.1 microgram/cm².
- (3) Measurement of dust fall with a detection threshold equivalent to a Class 300 cleanliness level.
- (4) Detection and identification of trace quantities by hydrocarbons, phthalate esters, silicones, NH₃, HCl, NO_x, NH₄, OH, HNO_x, and other possible contaminants at concentrations of a few ppm.

**Table 6-2. Example of Completed Form From
User Reference Book (Cont'd)**

- (5) H₂O vapor concentration and dew point measurement.
- (6) Air temperature measurement
- (7) Total pressure measurement from atmospheric to 10^{-3} Torr.

Specific measurements to be made during orbital operations are:

- (1) Map the directional fluxes of condensible molecules in the cargo bay as a function of time at levels of 10^{-10} grams/cm²/sec with 1 min resolution and detect long term changes smaller than 10^{-8} gm/cm².
 - (2) Measure the heats of absorption and evaporation rates of the above molecules.
 - (3) Assess the optical damage produced by the above molecules by continuously monitoring the transmission and hemispherical scattering of an optical surface with a detection threshold of a 1% change. A more detailed analysis of the deposited material and its optical properties will be performed post-flight on the recovered samples.
 - (4) Measure the condensation rate of returning H₂O molecules on a cryogenic surface at level of 10^{12} molecules/cm²/sec.
 - (5) Measure the column density of various species in the spacecraft induced atmosphere with a detection capability of 10^{10} - 10^{-2} molecules/cm².
 - (6) Determine the number of dust particles larger than 5 microns in the vicinity of the spacecraft; measure their size, positions, and velocities; and determine their origin.
 - (7) Determine the background brightness from unresolved particles and molecules at background levels of 6×10^{-15} solar brightnesses.
- (b) What Types of Payloads:
Automated, automated with the IUS and Spacelab.
 - (c) What STS Elements are Involved:
Orbiter, Spacelab, and IUS
 - (d) Describe Interface Requirements:
Shuttle Power and Distribution
Special Purpose GSE as Required
Compatible with RMS for Positioning

**Table 6-2. Example of Completed Form From
User Reference Book (Cont'd)**

5.	IDENTIFICATION OF FIRST POTENTIAL USER AND YEAR OF FIRST USE:	
	First Orbital Flight Test (OFT) in mid-1979.	
6.	IDENTIFY ALL POTENTIAL USERS:	
	1979-1981 All (OFT payloads, LDEF, Spacelab)	
	1982-1991 New payload configurations and by request for NASA and DoD payloads concerned with contamination	
7.	ESTIMATE FLIGHT RATE:	
	1979-1981	All
	1982-1991	TBD
8.	EQUIPMENT COST ESTIMATE:	
	Non-Recurring	} Approximately \$3.8 Million
	Recurring	
	Development Schedule - Begin design in Fiscal Year 1977	
9.	POTENTIAL VALUE OF EQUIPMENT:	
	Contamination protection provided by concerned payloads	
10.	STATUS:	
	First two units and spares are under development	
11.	REFERENCE(S) FOR ADDITIONAL DATA:	
	a.	MMC Contamination Study
	b.	Draft of IECM Report Provided by NASA (H. Gangl) 8 April 1976
	c.	Project Plan, IECM for OFT 1-6 and LDEF, MSFC, October 1976
12.	CONTACT:	
	G. M. Arnett - NASA/MSFC	

**Table 6-3. List of Ancillary Equipment Data Forms In
User Reference Book**

GROUND EQUIPMENT

- 1. Launch Site Transportation System**
 - a. Payload Canister - KMA-MH-10 (A70-0861)**
 - b. Transporter, Payload Canister - KMA-MH-39 (P70-0559)**
 - c. Payload Handling Fixture (Strong Back) - KMA-MH-19 (H70-0802)**
 - d. Environmental Conditioning Unit (ECU) - KMA-MH-44 (H70-0831)**
 - e. Instrumentation and Communication Unit (I&C) - KMA-MH-26 (H70-0832)**
 - f. Payload Canister Access Equipment - KMA-MH-03 (A70-0864)**
- 2. Launch Site Service Carts**
 - a. Set, Hydrazine Service - KMB-MS-01**
 - b. Set, Instrument Gas Service - KMB-MS-02**
 - c. Set, Liquid Helium Service - KMB-MS-0**
 - d. Cart, Payload Purge - KMB-MS-09**
 - e. Set, Liquid Hydrogen Service - KMB-SS-02**
 - f. Set, Liquid Nitrogen Service - KMB-SS-03**
 - g. Set, Liquid Oxygen Service - KMB-SS-05**

**Table 6-3. List of Ancillary Equipment Data Forms In
User Reference Book (Cont'd)**

GROUND EQUIPMENT (CONT'D)

- 3. Multipurpose Work Stands, Access Platforms, and Slings**
 - a. Access Platform, Spacecraft Assembly Stand, Vertical - KMB-MH-06**
 - b. Sling Set, Multipurpose - KMB-MH-27**
 - c. Stand, Spacecraft Assembly, Vertical - KMB-MH-34**
 - d. Stand, Work, Payload Assembly/Test, Horizontal - KMB-AH-30**
- 4. Cargo Integration Test Equipment**
- 5. Outsized Payload Transportation System**

SPACEBORNE EQUIPMENT

- 1. Pointing and Stabilization Systems**
 - a. Small Instrument Pointing System (SIPS)**
 - b. Annular Suspension and Pointing System (ASPS)**
 - c. Instrument Pointing System**
- 2. Electrical Cabling**
 - a. Automated Payload/IUS Cabling - 330-03-09-02**
 - b. Automated Payload/Orbiter Cabling - 330-03-09-01**
- 3. Contamination Monitoring**
 - a. Induced Environment Contamination Monitor (IECM)**
 - b. Trace Gas Analyzer**

**Table 6-3. List of Ancillary Equipment Data Forms In
User Reference Book (Cont'd)**

SPACEBORNE EQUIPMENT (CONT'D)

- 4. Manned Maneuvering Unit**
- 5. Auxiliary Power Systems**
 - a. Auxiliary Payload Power System (APPS)**
 - b. Multi-Discipline Auxiliary Payload Power System (MAPPS)**
- 6. Payload Specialist Station**
- 7. RTG Cooling Unit**
- 8. Second Ku-Band Antenna**
- 9. Cradle/Non-IUS Payload**
- 10. Multi-Use Fluid Lines Kit**
- 11. Umbilical Connector**
- 12. Avionics Equipment**
 - a. Multiplexer/Demultiplexer**
 - b. Electrical Isolation, Conditioning, and Distribution Assembly**
 - c. Dedicated Recorder**
 - d. PCM Unit**
 - e. DC-DC Converter/Regulator**

7. CONCLUSIONS AND RECOMMENDATIONS

As the Space Shuttle Program progresses and payload programs are defined, it is anticipated that requirements for ancillary equipment items (see Section 5) will be firmed up. Items which currently are only planned or conceptual will become defined and the hardware fabricated. The User Reference Book should be considered a "living" document, to which pages would be added and/or updated as data become available.

Extra sets of small multipurpose slings, test stands, dollies, etc. for use away from the base should be kept in an inventory at KSC and/or VAFB. When a payload contractor or STS user needs such ancillary equipment, it can be shipped to him rather than the contractor having to build payload-unique equipment. If more sets are needed, NASA should provide specifications and drawings of the ancillary equipment to save design costs.

Documentation describing intersite transportation equipment arrived too late to be incorporated in this study. It is recommended that this data be incorporated as an additional category of ground equipment as a task in a follow-on effort.

When an item of ancillary equipment is designed, built, and available for use by a payload contractor, photographs should be taken and added to the descriptive material in the User Reference Book. This will provide the potential user with a much better image than the sketch included originally in the equipment description.

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